Contamination rate of blood tests and its determining factors

Taxa de contaminação de testes hematológicos e seus fatores determinantes

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Abstract

Objective: Determining the contamination rate of blood cultures and its determining factors.
Methods: During a period of six months, were analyzed 564 blood culture samples requested at hospital emergency wards and 46 nurses were inquired.
Results: In a period of six months, among a total of 564 requests, 92 blood cultures were contaminated, which corresponds to a contamination rate of 16.31%. The determining factor was the use of low-level sterile technique.
Conclusion: The contamination rate of blood cultures is directly related to the procedures used by the nursing staff, and the workload is directly related to errors in the sterile technique of collection.

Resumo

Objetivo: Conhecer a taxa de contaminação de hemoculturas e os seus fatores determinantes.
Métodos: Foram analisadas 564 amostras de hemoculturas requisitadas num serviço hospitalar de urgências e questionados 46 enfermeiras(os) durante um período de seis meses.
Resultados: Produziram-se 92 contaminações de hemoculturas de um total de 564 requisições num período de seis meses, o que corresponde a uma taxa de contaminação de 16,31%. O fator determinante foi a utilização de técnica pouco estéril.
Conclusão: A taxa de contaminação das hemoculturas está diretamente relacionada aos procedimentos utilizados pelos profissionais de enfermagem e a carga de trabalho está diretamente associada a erros na técnica estéril de coleta.

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Introduction

Among the various diagnostic tests that take place in emergency services, the blood cultures stand out. It is a diagnostic tool used to isolate, detect and identify the microorganisms present in the blood, for further observation of their susceptibility in order to choose the appropriate treatment.[1-3] Contamination of blood cultures is a frequent problem in any hospital. A blood culture is considered to be contaminated if the presence of the following microorganisms is observed in 50% of all blood culture kits extracted in a day from a patient: *S. coagulase*-negative, alpha-hemolytic *Streptococcus*, *Micrococcus* species, *Propionibacterium* species, *Corynebacterium* species and *Bacillus* species.[4-6]

According to the American Society for Microbiology the contamination levels of samples should not exceed 3%, although they frequently exceed 7%.[7]

The suppression of false positives to the highest possible extent is a measure of great impact, since this could prevent the realization of additional testing, the administration of possibly unnecessary medication, and increase the hospital stay of patients, implying an important finance expense.[5,8-10]

The main cause of contamination is linked to manipulation by the nursing staff, especially in hospital services with a large workload and limited time to work with each patient.[11] Following are highlighted some of the most relevant factors related to the practice itself, according to the literature.

Regarding the collection technique, each protocol differently emphasizes some predictable factors that contribute to the lack of sterility of the sample.

A contributing factor is the effectiveness of the antiseptic used, which is defined as the drug of nonspecific action and strictly external use that is capable of destroying or inhibiting the growth of microorganisms living or temporarily present on the skin or mucous membranes.[12,13] In addition to its composition, antiseptics are different due to its speed and residual effect.

The effectiveness of any antiseptic is related to the waiting time of drying.[8] Studies were also published about this data, specifying that the tincture of iodine acts 30 seconds after applying, while povidone iodine needs two minutes. Regarding the biguanides, the 2% aqueous chlorhexidine requires a time close to two minutes, and the alcoholic based chlorhexidine needs 15-30 seconds.[14] In any case it seems that this (alcoholic based chlorhexidine) is more effective than alcohol and povidone iodine when it comes to reducing the number of contaminated samples.[8,9] In this sense, a combination of chlorhexidine and 70% isopropyl alcohol (ChloraPrep®) could reduce the rate of contamination of blood cultures even more.[14,15]

The use of sterile gloves influences the amount of contamination and reduces the number of microorganisms responsible for the creation of false positives by up to 50%.[16,17] Its use should be reduced to the moments prior to preparation of the patient's skin, i.e. the location of the point of puncture and cleaning of the skin. Sterile gloves should be used from the waiting time of drying the antiseptic to reduce the risk of contamination of fluids due to the presence of microorganisms on the skin of professionals.[2]

Regarding the amount of blood extracted by tube, with at least 10 ml, between 90 and 95% of microorganisms are obtained, although the current recommendations are 20 ml per tube.[1,2,7]

Our hypothesis is that contamination of blood cultures in a hospital is higher than we thought, and that it happens in the emergency service in particular, where rushing in carrying out diagnostic tests and taking medical decisions presumably hinders the following of established protocols at the same time that it increases the percentage of mistakes, and therefore also increases the percentage of infected cultures.

The aim of this study was to determine the contamination rate of blood cultures and its determining factors.

Methods

This is a descriptive observational and mixed study carried out at the Hospital Lluís Alcanyís, located in Xàtiva, in the city of Valencia, Spain.

Between the months of October 2012 and March 2013 were studied 564 blood cultures collected in the emergency department. In this period, 46 nurses of service agreed to participate. The method of intentional cluster sampling was used. Most professionals of the emergency service were women (74%), aged between 35 and 50 years. Regarding the time since graduation, 52% had between 11 to 20 years, 32.6% over 20 years, 13% between 5-10 years and 2.2% less than five years.

Two methodologies were used to obtain the study data: on the one hand, the contaminated samples were detected, and on the other hand was designed an ad-hoc survey from the data of the protocol for blood cultures collection and predisposing factors for contamination.

The nursing staff from emergency working under a formal contract was included in the study. On the arranged dates they participated in the survey on techniques and knowledge for collection of blood culture. Were excluded from the study the nurses to whom the questionnaire was presented and decided not to participate, and professionals unable to participate in the questionnaire due to sickness leave. Similarly, were eliminated blood cultures collected on emergency after the study period, and samples of doubtful contamination according to the criteria of the microbiology staff.

The survey was available on paper form and online, created with Google Docs. The paper questionnaire was given to professionals in person, along with an envelope to ensure anonymity. The online questionnaire was sent by email to the professionals who did not work in the center.

The information for detecting contaminated samples was obtained from file access to samples of the microbiology service via GestLab® software by conducting a search for positive samples analyzed in the period from October 2012 to March 2013 with aerobic and anaerobic tubes; inspecting the data of positive blood cultures according to the microorganism; reviewing the positive samples infected with *S. Epidermidis*, *S.* coagulase-negative, *S. hominis*, *Corynebacterium spp.*, *Staphylococcus spp.*, *P. spp.*, *Corynebacterium matruchotii* and *Micrococcus luteus*, to assess possible contamination; organizing the data by month and day of week and evaluating the origin of the samples in order to focus the study only on emergency service.

The questionnaire comprised of 15 questions, divided in two parts: in the first part was collected sociodemographic information (age, gender, time since graduation), and in the second part was collected information about the knowledge of nurses regarding the following of sample collection protocols (use of gloves, disinfection of skin, number of needles used, drying time, handling of vials).

The study was carried out from October to March due to the possible lack of data about professionals that were on holidays in periods prior to the start month. However, most of the sample was composed of the regular professional staff of the service. The survey period coincided with the final dates of the study period, in which were evaluated the techniques used by staff throughout the study period.

Statistical analysis was performed using the SPSS 20.0®. First were calculated the most important descriptive statistics for the study variables and then it was determined if there were differences in the studied variables in relation to gender. The percentages and graphs of qualitative variables as well as data on contaminated blood cultures were obtained by Excel®.

The development of study followed the national and international standards of ethics in research involving human beings.

Results

There were 564 requests for samples, among which 92 were contaminated, i.e. 16.31% of the requested samples. Following, are exposed the samples and its contamination in relation to the months of the study (Table 1). October was the month with the highest number of contaminations (23.85%) and January the month with the lowest proportion of contaminated samples (9.85%).

Table 1. Requests for blood cultures, contamination and percentage of contamination by month

Month	Requests	Contamination nº	Contamination %
October	109	26	23.85
November	33	7	21.21
December	110	19	17.27
January	71	7	9.85
February	181	27	14.91
March	60	6	10
Total	564	92	16.31

Concerning the comparison of contaminated samples in relation to the type of contaminating bacteria (Figure 1), mostly aerobic bacteria were the causative, especially in October, and except for February, when the percentage of contamination by anaerobic bacteria was higher.

As for the day of the week with more records of contamination, Mondays stand out as the days in which, after analysis, the largest number of samples was contaminated. In this aspect, there were 25 records of contaminated samples on Mondays, 15 on Tuesdays, 17 on Wednesdays, 19 on Thursdays and 16 on Fridays.

With regard to the knowledge of nurses on collection protocols, 84% of them reported knowing all the steps to properly collect blood cultures, against 8.7% that admitted not to have this knowledge.

The following factors were examined in relation to the protocols: frequency of handwashing, use of sterile techniques, contact with the area of venipuncture, number of needles used, respect for drying time, cleaning during the procedure, antiseptic cleaning of vials and skin, compression before or after the needle extraction, the volume of blood drawn per vial, extraction from existing catheters.

Considering the frequency of handwashing, 57% of nurses reported always washing their hands before collection, 39% said to do it occasionally and 2.2% reported never doing it.

Regarding the use of sterile techniques, much of the nursing staff admitted not using sterile techniques (76%) for the collection of blood culture samples. The main reason for that was the reduced availability of the service (60%) or to a lesser extent, the lack of technique (6.5%).

Most nurses reported touching the area of venipuncture to find a vein (30.4%) after disinfecting the area.

When considering the number of needles used in the procedure of collection of blood cultures, 50% of the professionals often use devices directly from the patient to the vial, 26% admitted using two needles for extraction, 20% used a needle for everything and only 4% used more than two needles.

Most respondents reported to respect the waiting time required for drying the antiseptic before carrying out the procedure/technique (67.4%).

Analyzing the cleaning during the procedure, 37% of professionals admitted not using any antiseptic for the cleaning of vial. On the other hand, 34.8% reported using a gauze with antiseptic for each vial and 23.9% reported to use the same gauze

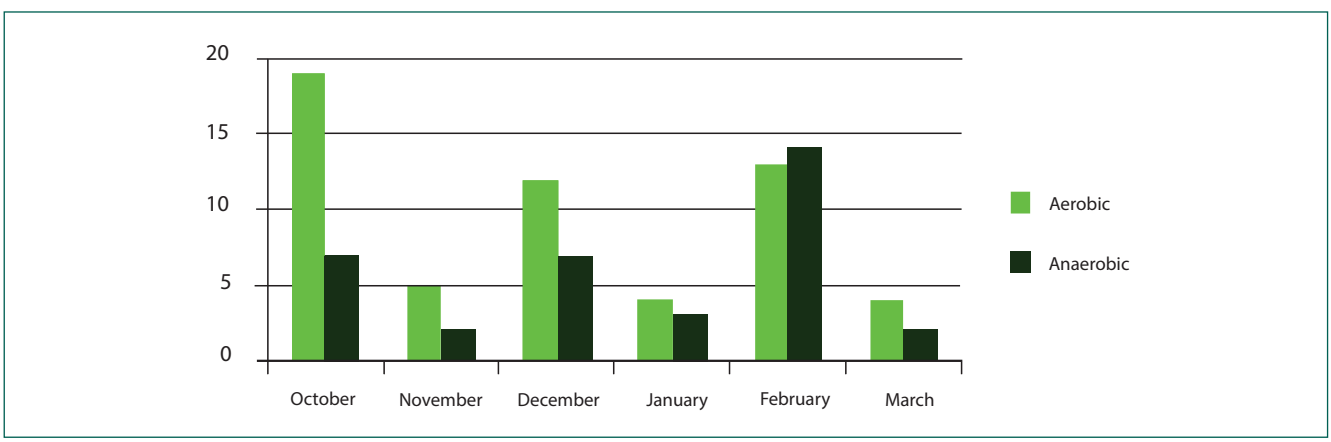

Figure 1. Comparison of contaminated samples by month and aerobic and anaerobic microorganisms

for two vials. Among those who used some antiseptic, a large percentage of professionals cleaned the vial with iodine (35%), a minimum percentage used chlorhexidine (4%) and 26% used alcohol.

The most widely used antiseptics for cleansing the skin are iodine (46%) and alcohol (43%) and the less used is chlorhexidine (11%).

A greater number of professionals reported extracting the needle before compressing the venipuncture zone (63%) compared to 30.4% who informed to compress on the needle.

Most professionals (67.4%) collected about 10 ml of blood to inoculate 5 ml per vial, compared to those who extracted 20 ml (17.4%) and other quantities (15.2%).

A high percentage of nurses collected blood from existing catheters in patients to do blood cultures (58%), compared to 2% who indicated always doing it and 39% who said they never did it.

Discussion

After analyzing the study data, the first information that stands out is that the contamination percentages in October, December and February show a directly proportional relationship with the number of blood cultures requests per month and the number of contamination of the samples, except for November.

After separating the blood culture vials in aerobic and anaerobic, the percentage of contamination of the first turned out to be significantly higher, which demonstrates a predisposition for an easier contamination. As stated in similar studies, the amount of blood inoculated into each vial influences its contamination, and insufficient or excessive inoculation could increase the presence of contaminants and lead to false positives.[8] In the case of a significant majority of aerobic contaminants, the explanation that best fits is the filling of aerobic vials at first, following the BACTEC® guidelines, although if aseptic conditions or management of fluids were not appropriate, this would lead to microorganisms presence in greater numbers in the first inoculation.

Regarding the relation between the contamination according to the day of the week, most of contaminated blood culture vials were detected on Mondays, which can be explained because a large percentage of samples was collected between Friday and Sunday, and the lab remained closed during this period.

Blood culture samples collected in the emergency room showed high levels of contamination. These data demonstrate a relationship between the workload of nursing staff and the samples ending up contaminated, which is in agreement with other studies.[11] The contamination rate of 16.31% far exceeds the 3% recommended by the American Society of Microbiologists and the 7% that occurs in other types of services.

After organizing professionals by age and time since graduation, it is possible to establish a relationship between the experience as nurses and the grade of knowledge on the collection technique. Despite the experience of the professionals, half of the inquired sample stated to wash their hands before the extraction procedure at all times, but not with an antiseptic, although these are the recommendations.[3,6]

In relation to the sterile technique, the studied professionals admitted to use sterile gloves, but not to use a sterile cloth for placing the material used for blood cultures collection because this recommendation is not in the procedure protocol of the center. Most reported not using a sterile technique, and this data was obtained in other studies too.[11]

The study predicted that the main reason for not using a sterile technique was the workload. However, a minor percentage was not familiar with the technique or unaware of the protocol.

In order to evaluate the sterility of the extracted fluid it was observed that a large percentage of the professionals touched the venipuncture area again after disinfecting the skin of the patient, a fact that increases contamination.[1-3,8,16]

Regarding the number of needles used, no significant results were obtained. According to the reviewed bibliography, the single-needle with pre-attached holder (Vacutainer®) is considered to increase the inoculation sterility of the tubes and reduce the

risk for professionals.[11] This data is favored by this study results since 50% of professionals admitted using a device directly from patients to the blood culture vial (Vacutainer®, intravenous catheter with obturator cap).

Regarding the tubes closure, the protocol of the center recommends cleaning the lids but does not emphasize which compound should be used for disinfection. However, the recommendations of inoculation of the BACTEC® devices suggest the use of ethanol, what is also supported in another study that used alcohol 70%.[17] In this study, most professionals reported to use iodine compounds for disinfection of the lids. In this sense, another study suggests stop using chlorhexidine or iodine compounds on the tube lids since it may damage the septum.[4] In contrast, another study claims that it is not necessary to disinfect the tube lids since they are open in a sterile manner and need not to be cleaned.[10]

As for the disinfection of the skin of patients, iodine was used mainly prior to venipuncture. On the other hand, some studies indicate chlorhexidine as the antiseptic of excellence.[4]

A large majority of respondents admitted extracting 10ml of blood per patient to inoculate 5 ml in each tube, which may have changed the number of positive samples once an amount of less than 8 or 10ml per tube might not be sufficient to detect one bacteremia.

Most professionals reported to occasionally obtain samples from venous catheters, despite the protocol emphasizing that blood should not be extracted from intravenous catheters under any circumstances, as corroborated by other studies,[6] unless in the case of suspected bacteremia associated with a microorganism present in the intravenous device,[1,3,6,18] and always in the case of a patient with a complicated venous access.[1]

Conclusion

The contamination rate of blood cultures was 16.31%. The procedures used by nursing professionals are directly related to the contamination of the samples, since they do not always follow the procedure protocol. The study hypothesis is confirmed: the main factor influencing the contamination of samples is the workload of the emergency service, in which many prescriptions for blood cultures are requested, what possibly favors the use of little sterile technique.

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Collaborations

De La Rubia-Ortí JE and Verdu-Trescolí G contributed to the project design, study execution, analysis and interpretation of data, writing, critical review of the relevant intellectual content and final approval of the version to be published. Prado-Gascó V and Firmino-Canhoto J collaborated in drafting the article, critical revision of the relevant intellectual content and final approval of the version to be published. Selvi-Sabater P contributed to the project design and execution of the research.

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